Membrane Concentration: VCF, Retentate and Yield

Volume concentration factor of a batch membrane plant, retentate concentration and yield of a component from its rejection, permeate quality and average flux.

Method: Batch concentration with constant rejection

Input parameters

Unit system: SI

Parameter	Value	Unit
Feed volume	10.000	m³
Permeate volume removed	8.0000	m³
Component concentration in the feed	3.3000	%
Rejection of the component	99.000	%
Membrane area	50.000	m²
Processing time	4.0000	h

Calculated results

Parameter	Value	Unit
Volume concentration factor	5.0000	
Retentate volume	2.0000	m³
Retentate concentration	16.237	%
Yield of the component in the retentate	98.403	%
Average permeate concentration	0.065858	%
Average flux	40.000	L/(m²·h)

Notes for this case

• Removing permeate concentrates retained components by the volume concentration factor VCF = V_f/V_r. With a constant rejection R, a component's retentate concentration rises as C_f·VCF^R and its yield in the retentate is VCF^(R−1): fully retained proteins (R ≈ 1) stay, lactose and minerals with low rejection pass partly. Flux falls as VCF rises and the retentate thickens, so the average flux over the batch is lower than the starting flux.

Formula and method

$$VCF = \frac{V_f}{V_f - V_p}, \quad C_r = C_f VCF^R, \quad Y = VCF^{R-1}$$

Variables

V_f	Feed volume	m³
V_p	Permeate volume removed	m³
C_f	Component concentration in the feed	-
R	Rejection of the component	-
A	Membrane area	m²
t	Processing time	s
VCF	Volume concentration factor	-
V_r	Retentate volume	m³
C_r	Retentate concentration	-
Y	Yield of the component in the retentate	-

$\bar{C}_p$	Average permeate concentration	-
J	Average flux	m/s

Method and standards

VCF.

Assumptions and limits

- Constant rejection; batch operation.

References

Batch concentration with constant rejection

Report details

Report reference	FCC-KS4B-TYFZ (the same inputs always give the same reference)
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Release checks	3 reference cases of this calculator, computed independently, are checked on every release

Results are for engineering estimation. Verify critical designs against the referenced standards and your own data.

This calculator online

https://calc.firecad.com/chemical/food-dairy/membrane-volume-concentration-factor

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.